

Overview

Multilayer piezoelectric actuators are ceramic elements used to convert electrical energy into mechanical energy such as displacement or force by utilizing the piezoelectric longitudinal effect.

KEMET’s multilayer piezoelectric actuators are produced based on our unique element structure design and piezoelectric ceramic materials with high electrostrictive factors. Compared to conventional piezoelectric actuators, they are smaller in size but can generate higher displacements and forces at low voltages.

The ASB Metal Sealed 85°C series actuators are less impacted by ambient humidity due to insulation from the atmosphere. As a result, long operational life and high performance have been attained which are ideal for use in various high reliability applications such as semiconductor device production equipment and optical communication equipment.

Benefits

- High reliability: Realization of MTTF = 36,000 hours at 85°C and 100 V
- Built-in pre-load mechanism and mounting attachments allowing for easier installation
- Accurate nanometer positioning
- Minimum mechanical abrasion
- Large generated force of 800 N
- Long operational life
- RoHS/REACH compliant



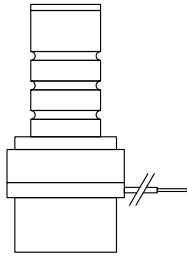
Applications

Typical applications include fine adjustment of various X-Y table steppers, mirror/prism positioning, linear motors, fluid flow control valve drive, vibration source and manipulators.

Ordering Information

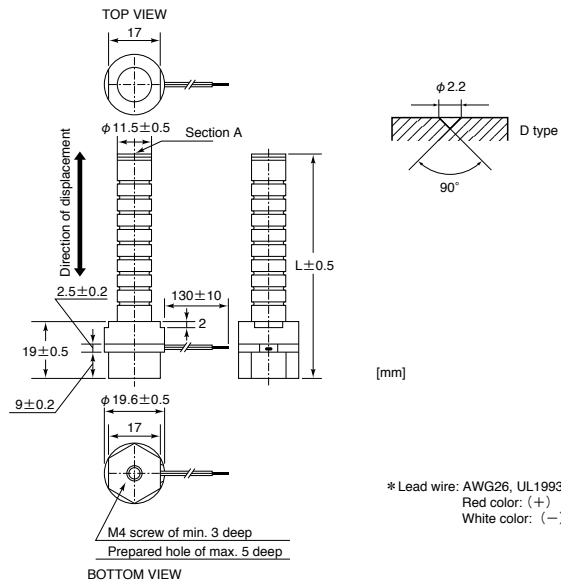
AS	B	170	C	801	N	D	0	LF
Series	Housing Construction and Operating Temperature Range	Nominal Displacement (µm)	Maximum Voltage (VDC)	Generated Force (N)	Mount Configuration	Drive Block Configuration	New Design	Environmental Compliance
AS = Encapsulated in Metal Case	B = Bellows (pre-load), maximum operating temperature of 85°C	The first two digits specify the displacement values. The last digit is an exponent of 10. Example: 170 = 17 µm	C = 150	The first two digits specify the values. The last digit is an exponent of 10. Example: 801 = 800 N = 80 kgf	N = Female thread type F = Flange type	D = V groove	Sequentially numbered starting from zero.	LF = RoHS/REACH Compliant (See “Environmental Compliance” below)

Female Thread Type

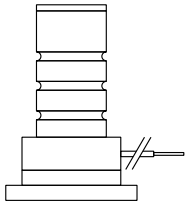


Female thread type

Model	L (mm)
ASB170C801ND0LF	38.4
ASB340C801ND0LF	58.4
ASB510C801ND0LF	78.4
ASB680C801ND0LF	98.4

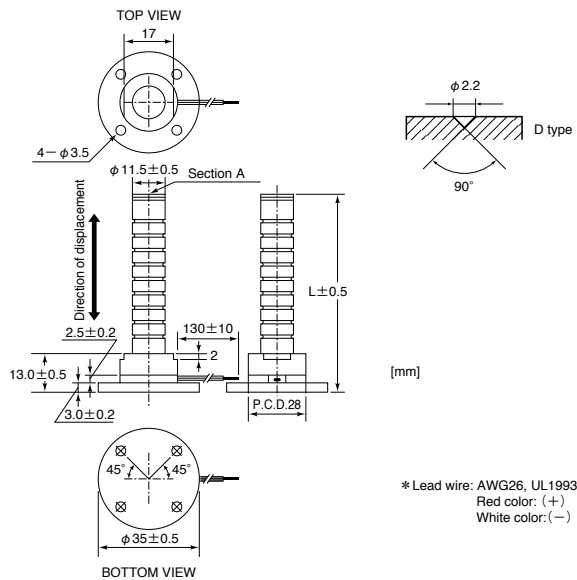


Flange Type



Flange type

Model	L (mm)
ASB170C801FD0LF	32.4
ASB340C801FD0LF	52.4
ASB510C801FD0LF	72.4
ASB680C801FD0LF	92.4



Metal Sealed Type Multilayer Piezoelectric Actuators

Item	Performance Characteristics	Conditions
Operating Temperature Range	-25 to +85°C	When applied with a DC voltage at ambient temperature. When driven by an AC voltage at ambient temperature plus temperature rise due to heat generation.
Recommended Storage Condition	-5 to +40°C	
Maximum Driving Voltage	150 VDC	
Displacement	See Table 1 - Ratings & Part Number Reference	At 150 VDC
Generated Force (Compression Resistance)	See Table 1 - Ratings & Part Number Reference	The force required for restricting the displacement to zero when the maximum driving voltage is applied.
Capacitance	See Table 1 - Ratings & Part Number Reference	$f = 1 \text{ kHz}, V = 1 V_{\text{rms}} (< 10 \mu\text{F})$ $f = 120 \text{ Hz}, V = 1 V_{\text{rms}} (> 10 \mu\text{F})$
Capacitance Tolerance	±20%	
Dissipation Factor	5% or less	
Insulation Resistance	See Table 1 - Ratings & Part Number Reference	Value obtained in one minute at 150 VDC.
Resonance Frequency	See Table 1 - Ratings & Part Number Reference	Both ends of the element are in free state. Typical values of the element under our test conditions.
Airtightness	1×10^{-8} atm cc/sec or less	
Temperature Cycle Test	Displacement: Initial value ±30% Capacitance: Initial value ±30% tan δ: Less than initial rated value Insulation Resistance: 1 MΩ or more	Room temperature (3 minutes) At -25°C for 30 minutes Room temperature (3 minutes) At +85°C for 30 minutes Repetition of 10 cycles of the above
High Temperature Shelf Test	Displacement: Initial value ±30% Capacitance: Initial value ±30% tan δ: Less than initial rated value Insulation Resistance: 1 MΩ or more	Temperature: 85 ±2°C Time: 1,000 ±48 h
Solvent Resistance Test	Displacement: Initial value ±30% Capacitance: Initial value ±30% tan δ: Less than initial rated value Insulation Resistance: 1 MΩ or more Appearance: No noticeable defect Mark: Easily legible	Solvent: Isopropyl alcohol Temperature: 23 ±5°C Time: Immersion for 1 minute
Heat Resistance Test	Displacement: Initial value ±30% Capacitance: Initial value ±30% tan δ: Less than initial rated value Insulation Resistance: 1 MΩ or more Appearance: No noticeable defect Mark: Easily legible	Temperature: 150 ±3°C Time: 96 ±4 h

Environmental Compliance

All KEMET Multilayer Piezoelectric Actuators are RoHS and REACH Compliant.

Article 33(1) of the REACH Regulation states that manufacturers and importers of articles (products) are required to notify their customers of the presence of any Substances of Very High Concern (SVHC) in their products exceeding 0.1% by weight and provide instructions on safe use of the product.

KEMET Corporation reports regarding the Article 33(1) of REACH Regulation as follows:

1. Applicable Product: Multilayer piezoelectric actuators (AE series and ASB Series)
2. Report for content of REACH SVHC list: The product(s) above contain a substance that is listed in the 8th update of the REACH SVHC 54 substances (December 19, 2012) which is included in the 14th update of the REACH SVHC 161 substances (December 17, 2015) by more than 0.1wt% per product weight.
3. Regarding safety of the multilayer piezoelectric actuators (Piezoceramic products): The Piezoceramic that is used in this product becomes ceramic by sintering powder containing PZT as a main ingredient. It is chemically stable, with minimum risks toward the human body or environment within the intended use of the product. Please note that risks could occur in the case of inhalation or accidental oral uptake of powder ceramics.
4. Technical product information on the multilayer piezoelectric actuators (Piezoceramic products): The manufacturing technique of the “piezoceramic products” whose main ingredient is Lead Titanium Zirconium Oxide (PZT) has been established, and there is no alternative material that can exhibit superior performance than PZT at this moment. Please note that the piezoceramic is listed as an exempt on RoHS (2011/65/EU) AnnexIII (7c.1).
5. Responsibility of piezoceramic manufacturers: Piezoceramic manufacturers report information regarding PZT containment in their products to the customers to obey the article 33 of the REACH regulation

Electrical Characteristics

Fig-10 Voltage vs. Displacement

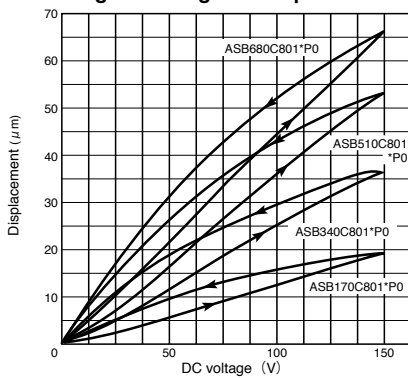


Fig-11 Compression load vs. Displacement

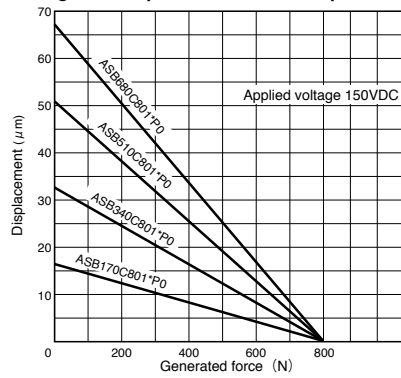


Fig-12 Drive frequency vs. Displacement

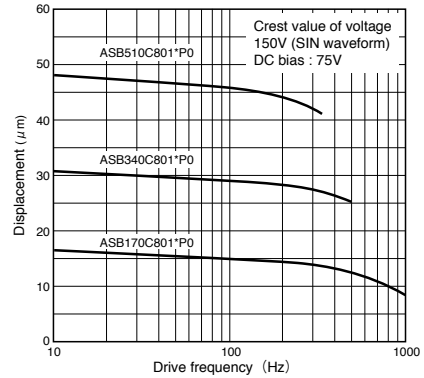


Fig-13 Temperature vs. Displacement

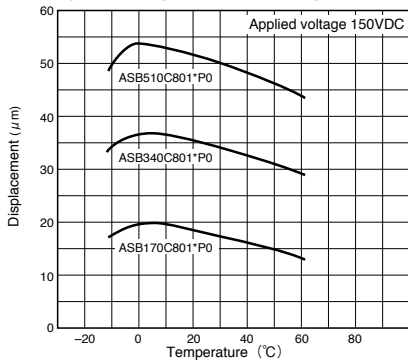


Fig-14 DC bias vs. Capacitance

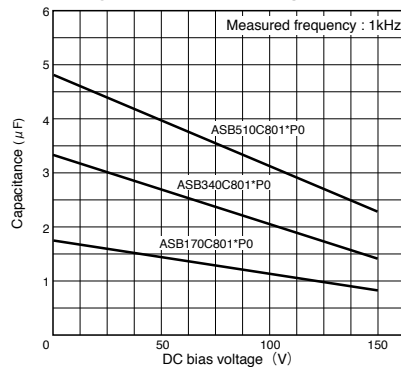


Fig-15 Temperature vs. Insulation resistance

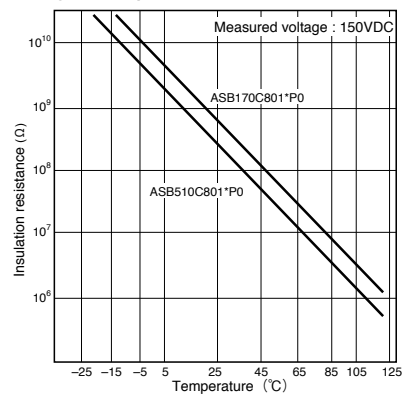


Table 1 – Ratings & Part Number Reference

Part Number	Electrical				Energy/Power	Displacement (µm) at Maximum Voltage of 150 VDC
	Capacitance (µF)	Resonance Frequency (kHz) Female Thread and Flange Type	Resonance Frequency (kHz) without Flange	Insulation Resistance (MΩ)	Generated Force (N)	
ASB170C801FD0LF	1.5	14	32	30	800	17.0 +/- 3
ASB170C801ND0LF	1.5	14	32	30	800	17.0 +/- 3
ASB340C801FD0LF	3	12	18	15	800	34.0 +/- 6
ASB340C801ND0LF	3	12	18	15	800	34.0 +/- 6
ASB510C801FD0LF	4.5	10	12	10	800	51.0 +/- 9
ASB510C801ND0LF	4.5	10	12	10	800	51.0 +/- 9
ASB680C801FD0LF	6	8	9	5	800	68.0 +/- 12
ASB680C801ND0LF	6	8	9	5	800	68.0 +/- 12

Reliability

The majority of failure modes on multilayer piezoelectric actuators are short-circuits due to degraded insulation. Although the cause of degradation of insulation has not been clarified, it has been found that the failure rate varies greatly between static uses (DC voltage application) and dynamic uses (pulse voltage application). Like other electrical components, piezoelectric actuators can be affected by humidity as well as applied voltage and ambient temperature. KEMET has added the metal sealed piezoelectric actuators featuring high reliability by eliminating the effects of the ambient atmosphere.

This section describes reliability guidelines for static and dynamic usage of the metal sealed type actuators. Reliability of our multilayer piezoelectric actuators is represented by MTTF (mean time to failure) in case of static usage. The number of repetitions is considered to represent the reliability in the case of dynamic usage.

DC Voltage Application

MTTFR of the metal sealed type under the actual operating conditions is calculated from the reference MTTFs and the acceleration factor as it is in the case of the resin coated type. However, since the internal element is sealed from the atmosphere, it is not affected by the atmospheric humidity. Therefore, equation (1) below is used.

$$(1) \text{MTTFR} = \text{MTTFs} \times A_v \times A_t$$

MTTFR : Estimated value

MTTFs : Reference value (= 36,000 hours)

A_v : Acceleration factor for drive voltage = $(100/V_R)^2$

A_t : Acceleration factor for ambient temperature = $1.5^{(85 - T_R)/10}$

V_R : Actual operating voltage (V)

T_R : Actual ambient temperature (°C)

The following calculation is made for the case of use at 25°C, and 150 V.

$$\begin{aligned} \text{MTTFR} &= 36,000 \times (100/150)^2 \times 1.5^{(85-25)/10} \\ &= 36,000 \times 0.44 \times 11.3 \\ &\approx 179,000 \text{ hours (20.4 years)} \end{aligned}$$

Pulse Voltage Application

Similarly to the resin coated type, it is extremely difficult to estimate reliability for the metal sealed type products by using an equation.

In KEMET's testing on the ASB170C801NP0, there was no failure confirmed up to 1,000 hours (equivalent to 100 million pulses applied) under the conditions below:

Temperature: 85 ±2°C

Humidity: 90 to 95% RH

Load: 200 N to 500 N (20 kgf to 50 kgf)

Drive voltage waveform: rectangular wave, 30 Hz, 0 to 100 V, duty ratio at 30%

User's Guide

Fixing Method

- Carefully prevent the piezoelectric actuators from being bent, twisted or applied tensile force.

Reference: Twisting and Tension Tolerance

	Reference Value	Remarks
Twisting Force	$3 \times 10^{-1} \text{ N} \cdot \text{m}$ or less	For an actuator which generates a force of 800 N (compression resistance).
Tension	50 N or less	

- Install the actuator so that the center axis of the generated displacement is aligned with the center axis of the load.
- Select the mounting bracket (female thread type or flange type) according to the mounting method and install the element utilizing the bracket.
- Fix the element securely so that the generated force and displacement cannot be deteriorated.
- Connect the driven item at the displacement generating end after securing the mounting portion, so that it avoids unnecessary stress applied at the time of installation.
- Though this product is designed to apply a compressive force to the internal element by the metal case, avoid any usage that can cause bending, twisting, or tension force when the device is in use.

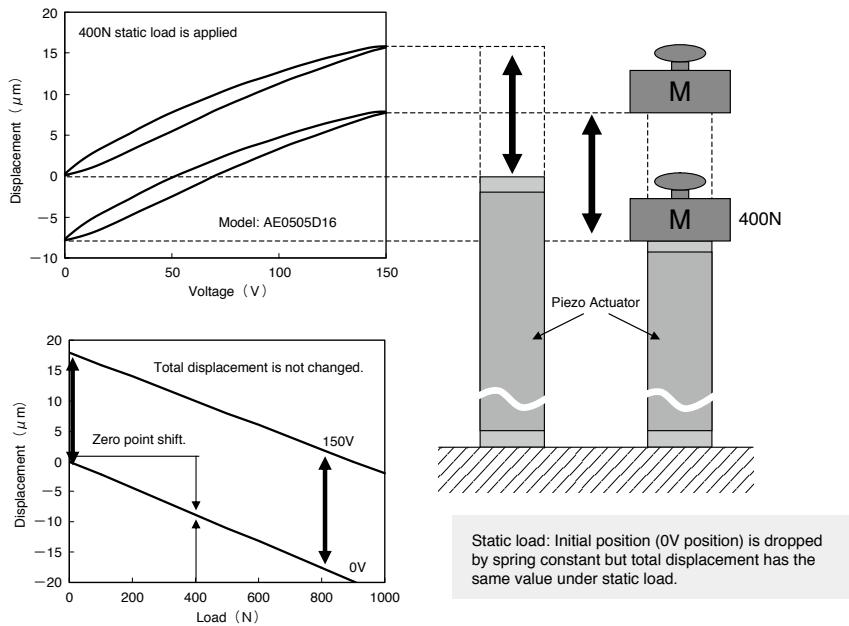
Driving Method

- Connect the red lead wire to the positive (+) terminal of the power supply. Also prevent reverse voltage application.
- In driving applications, it is necessary to take consideration of hysteresis, ringing, creep, and other similar phenomenons. For pulse driving, it is also necessary to be aware of self-heat generation, charge/discharge current, and the power supply's impedance.

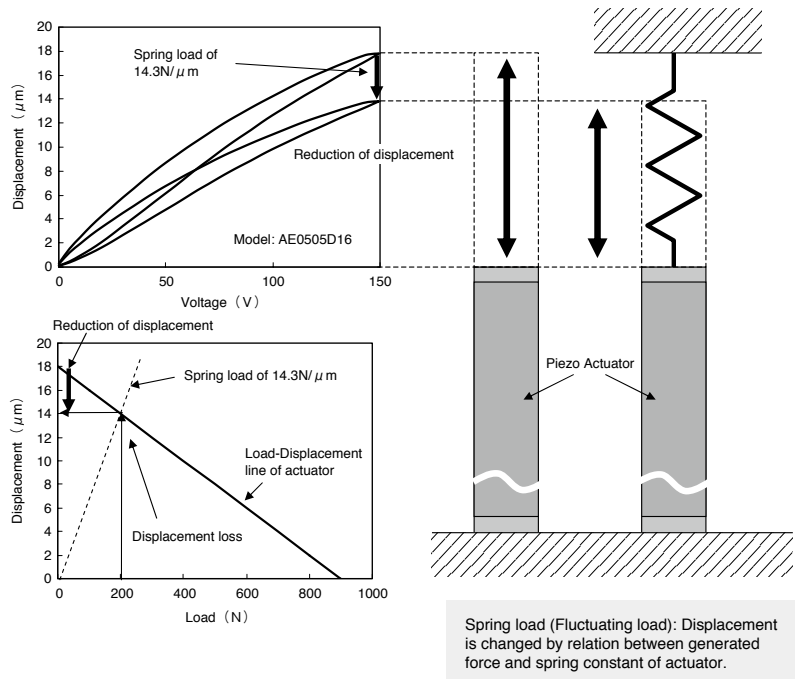
User's Guide cont'd

Generated force and load relation

Static load: No load value change when actuator moves.

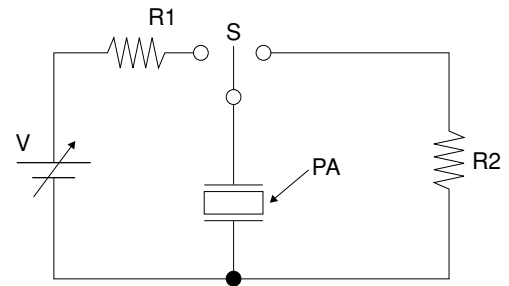


Fluctuating load: Load value changes by spring reaction when actuator moves.



Precautions

- Connect the red lead wire to the positive (+) terminal of the power supply.
- Avoid electric shocks since a high voltage is in use.
- Never apply excessive tension to a lead wire.
- Do not handle the product by picking up or moving the lead wire.
- Do not disassemble the case of the metal sealed type.
- Machining of the actuator element and replacement of the lead wire are prohibited.
- Avoid excessive physical shock. Otherwise, the internal piezoelectric ceramic element may be damaged.
- If the actuator is exposed to high temperatures above 100°C or if used after long storage periods (more than three months), the device should be polarized by using the circuit configuration and conditions shown at right.
- Do not apply voltage exceeding maximum rating voltage, or rapid charging and discharging.
- Do not use the actuator in high concentrations of highly inflammable gas.
- Align the center axis of displacement of the actuator with the center axis of the mechanical load.
- When operated, the transient response time of the actuator should be less than 1/3 of the resonant frequency in order to prevent damage by ringing.
- Store the metal sealed type (ASB series) preferably in a dry atmosphere (desirably below 40% RH) at ordinary temperatures (-5°C to +40°C). Avoid condensation on the product's surface.
- Store actuators where there is no vibration.
- Handle products properly as industrial waste. When disposing, please contact your local waste disposal service and make sure the disposal methods meet all legal requirements.



Protective resistor R1=1kΩ
 Protective resistor R2=1kΩ
 Polarizing conditions: DC voltage application
 0V → 150±0.2V (to be retained for 10 seconds) → 0

When using our products, the following precautions should be taken:

1. Safety designs allowing for failures of electronic components used in the system. In general, failures will occur in electronic components at a certain probability. KEMET makes every effort to improve the quality and reliability of electronic component products. However, it is impossible to completely eliminate the probability of failures. Therefore, when using KEMET's electronic component products, systems should be carefully designed to ensure the prevention of faulty operation and redundancy in the event of an accident which would result in injury or death, fire, or social damage. Please refer to Precautions when using multilayer piezoelectric actuators for more details of failures.
2. Quality level of various kinds of parts and equipment in which the parts can be utilized as electronic components have a standard quality level unless otherwise specified. KEMET classifies the level of quality of electronic component products into three levels: a standard quality level, a special quality level, and a custom quality level in which a customer individually specifies a quality assurance program. Each of the quality levels has recommended applications. If a user wants to use the electronic parts having a standard quality level in applications other than the applications specified for the standard quality level, they should always consult a KEMET representative before using the electronic parts.

Precautions cont'd

Standard Quality Level: Computers, office automation equipment, communication equipment, measuring instruments, AV equipment, household electrical appliances, machine tools, personal equipment and industrial robots.

Special Quality Level: Transportation equipment (automobiles, railways, shipping), traffic signals, disaster prevention/crime prevention systems, a variety of safety devices and medical equipment which are not directly intended for life-support purposes.

Custom Quality Level: Equipment for airplanes, aerospace equipment, nuclear power control systems, medical equipment and apparatus or systems for life-support purposes.

Unless otherwise specified, the quality level of KEMET's electronic component products shown in documents such as catalogs, datasheets or technical books are the standard quality level.

3. This manual is subject to change without notice. The content of this manual is based on data which is correct as of December, 2014 and they may be changed without notice. If our products are used for mass-production design, please consult with a member of our company's sales staff.
4. Reprinting and copying of this manual without prior written permission from KEMET Electronics Corporation is not permitted.
5. In the event of any problems associated with industrial property of a third party arising as a result of the use of our products, KEMET assumes no responsibility for problems other than directly associated with the constitution and manufacturing methods of the product.
6. Should any of these products come under the category of strategic goods or services (according to Japan's foreign trade and foreign exchange regulations), the sender must obtain an export license from the Japanese Government before said products can be exported outside Japan.

Precautions to be taken when using Multilayer Piezoelectric Actuators (Please read these precautions before using our products)

1. Before using or designing a system using our products, read the precautions and specifications (such as level of quality) for the products you intend to use.
2. The main failures with multilayer piezoelectric actuators are deterioration of insulation resistance, short-circuit, and open-circuit. Before using the products, design systems carefully to ensure redundancy, prevention of the spread of fire, and prevention of faulty operation allowing for the occurrence of failures.
3. Use the products after checking the working conditions and rated performance of each multilayer piezoelectric actuator series. Selection of AE series (resin coated type) or ASB series (metal sealed type) should be based on the intended working temperature and humidity.

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Although KEMET designs and manufactures its products to the most stringent quality and safety standards, given the current state of the art, isolated component failures may still occur. Accordingly, customer applications which require a high degree of reliability or safety should employ suitable designs or other safeguards (such as installation of protective circuitry or redundancies) in order to ensure that the failure of an electrical component does not result in a risk of personal injury or property damage.

Although all product-related warnings, cautions and notes must be observed, the customer should not assume that all safety measures are indicated or that other measures may not be required.